

# PATENT ABSTRACTS OF JAPAN

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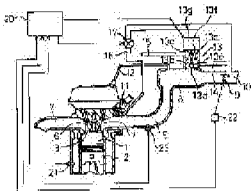
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(21)Application number : 06-041344 (71)Applicant : TOYOTA MOTOR CORP

(22)Date of filing : 11. 03. 1994 (72)Inventor : HOSHI KOICHI

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(54) FUEL INJECTION DEVICE OF INTERNAL COMBUSTION ENGINE



(57)Abstract:

PURPOSE: To suppress the reverse flow of the intake and the in-flow of the fuel into an air assist passage by controlling a closing valve in a passage open to the atmosphere which opens the downstream of a control valve of the air assist passage to the atmosphere so as to be open when the pressure increase in the downstream of a throttle valve exceeds the prescribed value.

CONSTITUTION: An assist air chamber is provided with a fitting part of a fuel injection valve 11 arranged on intake manifold 5, and atomizes the injected fuel by providing the assist air into a fuel passage of the fuel injection valve 11. The assist air is supplied from a low pressure

chamber 13c of a bypass control valve 13 arranged outside a surge tank 8 through a connecting pipe 15, and the flow rate is controlled by driving first and second valves 13d, 13f by an actuator 13g. A passage 16 open to the atmosphere which opens the connecting pipe to the upstream of a throttle valve 9 of an intake passage 10 is connected to the connecting pipe 15 by interposing a closing valve 17, and the closing valve 17 is opened when the intake pressure exceeds the prescribed value.

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#### CLAIMS

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[Claim(s)]

[Claim 1] The air assistant path which is open for free passage the throttle-valve upstream of an inhalation-of-air path, and near the

nozzle hole of the fuel injection valve arranged on the throttle-valve lower stream of a river of said inhalation-of-air path, The control valve for being arranged at said air assistant path and controlling the amount of assistant air, The atmospheric-air disconnection path which opens said control valve downstream of said air assistant path to atmospheric air, The fuel injection equipment of the internal combustion engine characterized by providing the closeout valve arranged at said atmospheric-air disconnection path, and the first control means which makes said closeout valve open when the pressure buildup of the throttle-valve downstream of said inhalation-of-air path becomes beyond a predetermined value.

[Claim 2] Furthermore, the fuel injection equipment of the internal combustion engine according to claim 1 characterized by providing the second control means which makes said closeout valve open at the time of a fuel cut.

[Claim 3] The air assistant path which is open for free passage the throttle-valve upstream of an inhalation-of-air path, and near the nozzle hole of the fuel injection valve arranged on the throttle-valve lower stream of a river of said inhalation-of-air path, The control valve for being arranged at said air assistant path and controlling the amount of assistant air, The atmospheric-air disconnection path which opens said control valve downstream of said air assistant path to atmospheric air, The fuel injection equipment of the internal combustion engine characterized by providing the closeout valve arranged at said atmospheric-air disconnection path, and the third control means which makes said closeout valve open when the pressure of the throttle-valve downstream of said inhalation-of-air path turns into more than a predetermined pressure.

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[Translation done.]

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Industrial Application] Especially this invention relates to the fuel injection equipment of the internal combustion engine to which the air assistant path for supplying assistant air near the nozzle hole of a fuel injection valve is connected, in order to make atomization of the injected fuel good.

[0002]

[Description of the Prior Art] Such an internal combustion engine's fuel injection equipment has already become well-known, for example, the upstream of an air assistant path is connected to JP,4-295178,A for the throttle-valve upstream of an inhalation-of-air path through a control valve, and the fuel injection equipment which has differential pressure type air assistant equipment which supplies assistant air near the nozzle hole of a fuel injection valve is indicated using the differential pressure generated between the upstream of a throttle valve, and a lower stream of a river. In this differential pressure type air assistant equipment, the amount of assistant air is adjusted by the above-mentioned control valve, and the inspired air volume needed in each engine operational status is supplied into a cylinder together with the inhalation of air supplied through a throttle valve.

[0003]

[Problem(s) to be Solved by the Invention] In order for an inhalation-of-air path to pass a lot of inhalation of air at the time of an engine heavy load etc., while the cross section is enlarged comparatively, in order that [ of such an air assistant path ] especially the control valve downstream may raise the rate of flow of assistant air, the cross section is comparatively small. Although the pressure of the throttle-valve downstream of an inhalation-of-air path will rise quickly and atmospheric pressure will be approached if whenever [ throttle valve-opening ] increases rapidly like [ at the time of engine sudden acceleration ] by that cause Even if the opening of a control valve increases rapidly in connection with it, the control valve downstream of an air assistant path Since it is maintained for a while with negative pressure, inhalation of air flows backwards from the inhalation-of-air path of the throttle-valve downstream to an air assistant path by the meantime, and some injected fuels It flows into an air assistant path with this inhalation of air that flows backwards, and while the air-fuel ratio at this time serves as Lean from a request value and an output

declines, the exhaust gas clarification engine performance in a three way catalytic converter gets worse.

[0004] Therefore, the object of this invention is offering the fuel injection equipment of the internal combustion engine which can reduce the inflow of the fuel accompanying a back run and it of the inhalation of air to the air assistant path which possesses air assistant differential pressure-type equipment and is generated at the time of a sudden rise of the pressure of the throttle-valve downstream of an inhalation-of-air path.

[0005]

[Means for Solving the Problem] The fuel injection equipment of the first internal combustion engine by this invention The air assistant path which is open for free passage the throttle-valve upstream of an inhalation-of-air path, and near the nozzle hole of the fuel injection valve arranged on the throttle-valve lower stream of a river of said inhalation-of-air path, The control valve for being arranged at said air assistant path and controlling the amount of assistant air, It is characterized by providing the atmospheric-air disconnection path which opens said control valve downstream of said air assistant path to atmospheric air, the closeout valve arranged at said atmospheric-air disconnection path, and the first control means which makes said closeout valve open when the pressure buildup of the throttle-valve downstream of said inhalation-of-air path becomes beyond a predetermined value.

[0006] The fuel injection equipment of the second internal combustion engine by this invention is characterized by providing further the second control means which makes said closeout valve open at the time of a fuel cut in the first above-mentioned internal combustion engine's fuel injection equipment.

[0007] The fuel injection equipment of the third internal combustion engine by this invention The air assistant path which is open for free passage the throttle-valve upstream of an inhalation-of-air path, and near the nozzle hole of the fuel injection valve arranged on the throttle-valve lower stream of a river of said inhalation-of-air path, The control valve for being arranged at said air assistant path and controlling the amount of assistant air, It is characterized by providing the atmospheric-air disconnection path which opens said control valve downstream of said air assistant path to atmospheric air, the closeout valve arranged at said atmospheric-air disconnection path, and the third control means which makes said closeout valve open when the pressure of the throttle-valve downstream of said inhalation-of-air

path turns into more than a predetermined pressure.

[0008]

[Function] The air assistant path where the first above-mentioned internal combustion engine's fuel injection equipment is open for free passage the throttle-valve upstream of an inhalation-of-air path, and near [ which have been arranged on the throttle-valve lower stream of a river of an inhalation-of-air path ] the nozzle hole of a fuel injection valve, The control valve for being arranged at an air assistant path and controlling the amount of assistant air, Have the atmospheric-air disconnection path which opens the control valve downstream of an air assistant path to atmospheric air, and the closeout valve arranged at the atmospheric-air disconnection path, and when the pressure buildup of the throttle-valve downstream of an inhalation-of-air path becomes beyond a predetermined value about a closeout valve, in order to open, the first control means At this time, the pressure of the control valve downstream of an air assistant path rises to atmospheric pressure quickly.

[0009] Moreover, in the first above-mentioned internal combustion engine's fuel injection equipment, at this time, the pressure of the control valve downstream of an air assistant path is quick, and the second above-mentioned internal combustion engine's fuel injection equipment goes up to atmospheric pressure, in order for the second control means to make a closeout valve open at the time of a fuel cut.

[0010] Moreover, the third above-mentioned internal combustion engine's fuel injection equipment The air assistant path which is open for free passage the throttle-valve upstream of an inhalation-of-air path, and near the nozzle hole of the fuel injection valve arranged on the throttle-valve lower stream of a river of an inhalation-of-air path, The control valve for being arranged at an air assistant path and controlling the amount of assistant air, Have the atmospheric-air disconnection path which opens the control valve downstream of an air assistant path to atmospheric air, and the closeout valve arranged at the atmospheric-air disconnection path, and when the pressure of the throttle-valve downstream of an inhalation-of-air path turns into more than a predetermined pressure in a closeout valve, in order to open, the third control means At this time, the pressure of the control valve downstream of an air assistant path rises to atmospheric pressure quickly.

[0011]

[Example] Drawing 1 is an internal combustion engine's outline sectional view in which the fuel injection equipment of the first example by this

invention was attached. As for a combustion chamber and 2, in this drawing, 1 is [ a piston and 3 ] ignition plugs. The exhaust manifold 7 leads [ the inlet manifold 5 ] to the combustion chamber 1 through the exhaust valve 6 again through the inlet valve 4. The inlet manifold 5 for every cylinder has the comparatively big cross-sectional area in order to pass a lot of inhalation of air at the time of an engine heavy load, and it joins in a surge tank 8, and the inhalation-of-air path 10 common to each cylinder where the throttle valve 9 has been arranged is connected to the upstream. The fuel injection valve 11 is arranged at each inlet manifold 5. 12 in drawing is a crankcase emission control system for returning the blow-by gas drawn into a cam cover from a crank case to a surge tank.

[0012] Drawing 2 is the sectional view of a fuel injection valve 11. The adapter 50 is attached in the point as shown in this drawing. Two fuel paths 50a and 50b which extend to an adapter front end side, and at least two free passage ways 50c and 50d which are open for free passage from an adapter side face near the fuel injection valve nozzle hole of each fuel paths 50a and 50b are formed in that direction of fuel injection from two nozzle holes of a fuel injection valve 11 at this adapter 50. The air assistant room 51 is established in the circumference of an adapter side face, and the assistant air offered there is supplied to each fuel paths 50a and 50b through the free passage ways 50c and 50d, atomizes the fuel injected by the fuel injection valve 11 good in the installation section of a fuel injection valve 11, and emits to it from an adapter front end side.

[0013] The bypass-control valve 13 is arranged on the outside of return and a surge tank 8 at drawing 1 . In this bypass-control valve 13, it is divided into a septum by 13a at hyperbaric-chamber 13b of the upstream, and low-pressure-chamber 13c of the downstream, hyperbaric-chamber 13b and a surge tank 8 are opened for free passage through the 13d of the 1st valve element, and hyperbaric-chamber 13b and low-pressure-chamber 13c are opened for free passage through the 13f of the 2nd valve element arranged on same valve-stem as 13d of 1st valve element 13e. 13g is an actuator for operating through valve-stem 13e in the 13d of the 1st valve element, and the 13f of the 2nd valve element. Hyperbaric-chamber 13b is connected to the throttle-valve 9 upstream of the inhalation-of-air path 10 by the 1st communication trunk 14, and low-pressure-chamber 13c is connected to the air assistant room 51 by the 2nd communication trunk 15.

[0014] Moreover, the atmospheric-air disconnection path 16 for opening it to the throttle-valve 9 upstream of the inhalation-of-air path 10,

i.e., atmospheric air, is connected to the 2nd communication trunk 15, and the closeout valve 17 is arranged at this atmospheric-air disconnection path 16.

[0015] The opening of the 13d of the 1st valve element in the above-mentioned bypass-control valve 13 and the 13f of the 2nd valve element changes, as those configurations show to drawing 3 according to the amount of displacement of valve-stem 13e. drawing 3 -- setting -- a continuous line -- the opening of the 13f of the 2nd valve element -- it is -- this opening -- valve-stem 13e -- predetermined -- a variation rate -- when reaching an amount A, it is opened fully, and it increases from a close by-pass bulb completely linearly by the meantime. moreover, a dotted line -- the opening of the 13d of the 1st valve element -- it is -- this opening -- valve-stem 13e -- predetermined -- a variation rate -- it is still a close by-pass bulb completely until it reaches an amount A, and it increases from a close by-pass bulb completely linearly to full admission after that.

[0016] Thus, the 13f of the 2nd valve element is usually selectively opened at the time of operation, therefore the 13d of the 1st valve element is made into a close by-pass bulb completely, it supplies assistant air near the nozzle hole of a fuel injection valve 11 through the 2nd communication trunk 15 by the differential pressure between the upstream of a throttle valve 9, and a lower stream of a river, and the constituted bypass-control valve 13 promotes the atomization of the injected fuel. This 2nd communication trunk 15 has the comparatively small cross section, in order to bring forward the rate of flow of the assistant air which passes along it. moreover, in order to stabilize combustion and to realize early warming up at the time of idle operation between the colds, in case a rotational frequency is raised While having to increase the quantity of inspired air volume to some extent with a fuel as compared with the time of idle operation between \*\*, opening the 13f of the 2nd valve element fully at this time and increasing the amount of assistant air The inhalation of air which the 13d of the 1st valve element is furthermore also opened, and bypasses a throttle valve 9 is supplied to a surge tank 8.

[0017] While 20 takes charge of control of such a general bypass-control valve 13 In order to be the control unit which takes charge of closing motion control of the closeout valve 17 arranged at the above-mentioned atmospheric-air disconnection path 16 and to detect engine operational status The revolution sensor for detecting the air flow meter (not shown) for detecting an inhalation air content, and an engine rotational frequency (not shown), The pressure-sensor 23 grade for detecting the

pressure in a sensor 22 and an inlet manifold 5 whenever [ for detecting the cooling coolant temperature sensor 21 for detecting cooling water temperature as engine temperature and the opening of a throttle valve 9 / throttle valve-opening ] is connected. Drawing 4 is the 1st flow chart for closing motion control of this closeout valve 17. This flow chart is performed for whenever [ predetermined crank angle / every ].

[0018] In step 101, a sensor 24 detects [ whenever / throttle valve-opening ]  $\theta_1$  whenever [ current throttle valve-opening ] first. Next, in step 102,  $\theta_2$  is subtracted from this value  $\theta_1$  whenever [ last throttle valve-opening ],  $\Delta\theta$  is computed whenever [ throttle valve-opening ], and it is judged in step 103 whether this  $\Delta\theta$  is more than the specified quantity A.

[0019] Since it is immediately after initiation of this flow chart at the engine idle time, it is denied and this decision progresses to step 104, and clausilium of the closeout valve 17 is carried out, it is memorized as  $\theta_2$  whenever [ this throttle valve-opening ] in step 106 for next processing of  $\theta_1$ , and is ended at the beginning. On the other hand, if whenever [ for sudden acceleration / throttle valve-opening ] increases rapidly during engine operation, the decision in step 103 will be affirmed, it will progress to step 105, and the closeout valve 17 will be opened.

[0020] While the pressure in the inlet manifold 5 which has the comparatively big cross section will rise quickly and atmospheric pressure will be approached if whenever [ throttle valve-opening ] increases rapidly like [ at the time of engine sudden acceleration ] since the fuel injection equipment possessing common differential pressure type air assistant equipment does not have such an atmospheric-air disconnection path 16, the pressure in the 2nd communication trunk 15 which has the comparatively small cross section is maintained for a while whenever [ throttle valve-opening ] by the negative pressure before rapid increase. Therefore, at this time, since inhalation of air flows backwards into the 2nd communication trunk 15 from an inlet manifold 5, some fuels injected in connection with it flow into the 2nd communication trunk 15 and need fuel quantity is not supplied to a combustion chamber 1, the air-fuel ratio at this time serves as Lean from a request value, and while an output declines, the exhaust gas clarification engine performance in the three way catalytic converter (not shown) of the exhaust-manifold 7 downstream gets worse.

[0021] However, since the closeout valve 17 is opened and the 2nd communication trunk 15 is opened by the atmospheric-air disconnection path 16 at atmospheric pressure when whenever [ throttle valve-opening ]

increases rapidly in this way, the fuel injection equipment of this example Go up quickly like [ the pressure in this 2nd communication trunk 15 ] an inlet manifold 5, and atmospheric pressure is approached. The inflow of the fuel accompanying the above-mentioned inhalation-of-air back run into the 2nd communication trunk 15 generated by these pressure differentials and it is prevented, and can solve the problem of aggravation of loss of power and exhaust air emission.

[0022] In the conventional configuration, when whenever [ throttle valve-opening ] increases rapidly, the thing of the bypass-control valve 13 for which the 13f of especially the 2nd valve element is rapidly considered as full admission is also considered, but generally, since comparatively long time amount is needed for fluctuating the opening of a valve element substantially, the above-mentioned problem so then still generates 13g of driving gears of the bypass-control valve 13 which enables the above fine adjustment.

[0023] In this example, the pressure in the 2nd communication trunk 15 can be raised still better by adding opening control of such a bypass-control valve 13. Furthermore, the atmospheric-air disconnection path 16 has that desirable in which it is [ communication trunk / 15 / 2nd ] more desirable to connect with the downstream if possible and to have the comparatively big cross section, and the closeout valve 17 of the atmospheric-air disconnection path 16 has the outstanding responsibility to the full admission from a close by-pass bulb completely at least. Moreover, in the 1st flow chart, although augend was used for closing motion control of the closeout valve 17 whenever [ throttle valve-opening ], only when the pressure in the direct inlet manifold 5 is detected and the amount of lifting  $\Delta p$  becomes beyond the predetermined value B with a pressure sensor 23, of course, even if it opens the closeout valve 17, the same effectiveness can be acquired.

[0024] Drawing 5 is the 2nd flow chart for another closing motion control of the above-mentioned closeout valve 17. The difference from the 1st flow chart is that the closeout valve 17 is opened, also when step 204 which judges activation of a fuel cut is added and the fuel cut is performed. A fuel cut suspends fuel injection for the purpose of fuel economy at the time of an engine sudden slowdown as generally known.

[0025] Including the time of an engine sudden slowdown, when whenever [ throttle valve-opening ] is small, the pressure in an inlet manifold 5 declines considerably, and big negative pressure generates it. In such a case, \*\* becomes [ the bottom of the oil by which the lubricating oil of an inlet valve 4 is consumed by burning in leakage and a combustion chamber 1 in an inlet manifold 5 through a valve guide ] remarkable.

Since according to the 2nd flow chart the inside of the 2nd communication trunk 15 is opened by the atmospheric-air disconnection path 16 at atmospheric pressure during the fuel cut which does not produce a problem especially even if it makes inspired air volume increase, a lot of assistant air is supplied in an inlet manifold 5 through the 2nd communication trunk 15 at this time, the pressure of its inside is raised, and the bottom of the oil at this time can control \*\*. [0026] Moreover, even if a fuel flows into the 2nd communication trunk 15 at the time of the sudden acceleration before this sudden slowdown, these assistant air of a lot of can discharge this fuel certainly into an inlet manifold 5, can prevent the corrosion of the 2nd communication trunk 15 by the fuel, further, can fully cool a fuel injection valve 11, and can prevent evaporation of the fuel within a fuel injection valve 11. [0027] Drawing 6 is an internal combustion engine's outline sectional view in which the fuel injection equipment of the second example by this invention was attached. Only the difference from the first example is explained below. In this example, closeout valve 17' of a differential pressure type is arranged at atmospheric-air disconnection path 16'. If as for this closeout valve 17' the pressure of the throttle-valve 9 upstream of the inhalation-of-air path 10 acts on one of diaphragm 17'a of these, the pressure in a surge tank 8 acts on another side and both differential pressure becomes smaller than the thrust of spring member 17'b at it, diaphragm 17'a will be deformed by spring member 17'b, valve element 17'c attached in it will be opened, and atmospheric-air disconnection path 16' will be opened.

[0028] Therefore, if the pressure of the throttle-valve 9 upstream of the inhalation-of-air path 10 is atmospheric pressure and it thinks that it is almost fixed By closeout valve 17' being opened when the pressure in a surge tank 8, i.e., the pressure in an inlet manifold 5, becomes beyond a predetermined value, and choosing this predetermined value as application The 2nd communication trunk 15 is opened during engine sudden acceleration to atmospheric air, and can solve the above-mentioned problem as well as the first example to it.

[0029] Since this example is automatically opened and closed without closeout valve 17''s needing a control unit If throttle-valve 9 opening increases and the pressure in an inlet manifold 5 exceeds a predetermined value even if it is not at the engine sudden acceleration time while being able to simplify structure as compared with the first example The 2nd communication trunk 15 will be opened by atmospheric air, and at this time, a lot of assistant air is supplied near the nozzle hole of a fuel injection valve 11, and can raise the atomization of a

fuel.

[0030] In two examples, although the upstream of the atmospheric-air disconnection path 16 and 16' is connected to the throttle-valve 9 upstream of the inhalation-of-air path 10, if an air cleaner is formed uniquely, opening to direct atmospheric air is also possible.

[0031]

[Effect of the Invention] Thus, according to the fuel injection equipment of the first internal combustion engine by this invention The air assistant path which is open for free passage the throttle-valve upstream of an inhalation-of-air path, and near the nozzle hole of the fuel injection valve arranged on the throttle-valve lower stream of a river of an inhalation-of-air path, The control valve for being arranged at an air assistant path and controlling the amount of assistant air, Have the atmospheric-air disconnection path which opens the control valve downstream of an air assistant path to atmospheric air, and the closeout valve arranged at the atmospheric-air disconnection path, and when the pressure buildup of the throttle-valve downstream of an inhalation-of-air path becomes beyond a predetermined value about a closeout valve, in order to open, the first control means At this time, the pressure of the control valve downstream of an air assistant path rises to atmospheric pressure quickly, the pressure differential between the throttle-valve downstream of an inhalation-of-air path becomes small, and the back run of the inhalation of air to an air assistant path and the inflow of a fuel are controlled, and can realize a desired air-fuel ratio.

[0032] Moreover, in order for the second control means to make a closeout valve open in the first above-mentioned internal combustion engine's fuel injection equipment at the time of a fuel cut according to the fuel injection equipment of the second internal combustion engine by this invention In addition to the effectiveness of the first internal combustion engine's fuel injection equipment, the pressure of the control valve downstream of an air assistant path rises to atmospheric pressure quickly during the fuel cut with the throttle valve near a close by-pass bulb completely. A lot of assistant air is supplied to the throttle-valve downstream of an inhalation-of-air path, that pressure is raised, and the bottom of the oil at this time can control \*\*.

[0033] Moreover, the air assistant path which is open for free passage the throttle-valve upstream of an inhalation-of-air path, and near the nozzle hole of the fuel injection valve arranged on the throttle-valve lower stream of a river of an inhalation-of-air path according to the fuel injection equipment of the third internal combustion engine by this

invention, The control valve for being arranged at an air assistant path and controlling the amount of assistant air, Have the atmospheric-air disconnection path which opens the control valve downstream of an air assistant path to atmospheric air, and the closeout valve arranged at the atmospheric-air disconnection path, and when the pressure of the throttle-valve downstream of an inhalation-of-air path turns into more than a predetermined pressure in a closeout valve, in order to open, the third control means The pressure of the control valve downstream of an air assistant path rises to atmospheric pressure quickly at the time of engine sudden acceleration etc., the pressure differential between the throttle-valve downstream of an inhalation-of-air path becomes small, and the back run of the inhalation of air to an air assistant path and the inflow of a fuel are controlled, and can realize a desired air-fuel ratio.

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#### DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] It is an internal combustion engine's outline sectional view in which the fuel injection equipment of the first example by this invention was attached.

[Drawing 2] It is the expanded sectional view of a fuel injection valve.

[Drawing 3] It is drawing explaining the opening of two valve elements of a bypass-control valve.

[Drawing 4] It is the 1st flow chart for closing motion control of a closeout valve.

[Drawing 5] It is the 2nd flow chart for opening control of a closeout valve.

[Drawing 6] It is an internal combustion engine's outline sectional view

in which the fuel injection equipment of the second example by this invention was attached.

[Description of Notations]

1 -- Combustion chamber  
4 -- Inlet valve  
5 -- Inlet manifold  
8 -- Surge tank  
9 -- Throttle valve  
11 -- Fuel injection valve  
13 -- Bypass-control valve  
14 -- The 1st communication trunk  
15 -- The 2nd communication trunk  
16 16' -- Atmospheric-air disconnection path  
17 17' -- Closeout valve

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[Translation done.]

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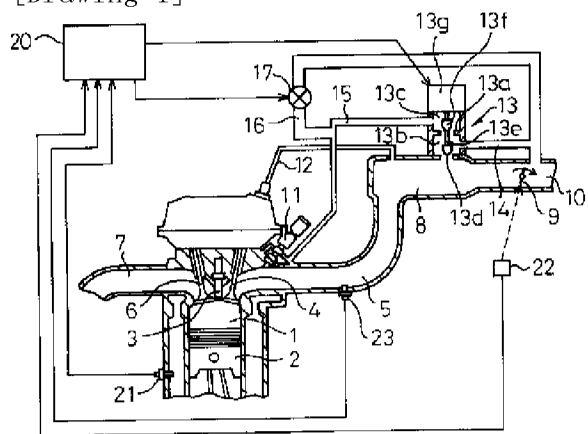
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DRAWINGS

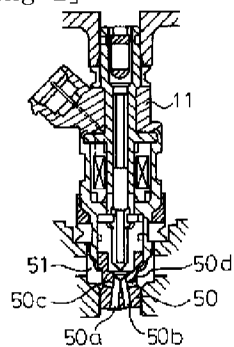
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[Drawing 1]



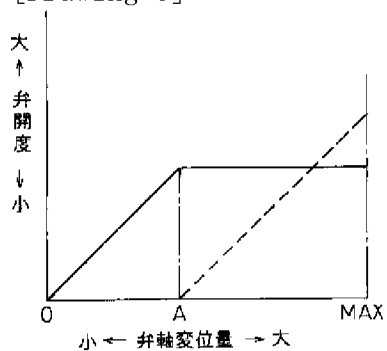
- |            |               |
|------------|---------------|
| 1…燃焼室      | 14…第1接続管      |
| 4…吸気弁      | 15…第2接続管      |
| 5…吸気マニホルド  | 16…大気開放通路     |
| 8…サージタンク   | 20…制御装置       |
| 9…スロットル弁   | 22…スロットル開度センサ |
| 10…燃料噴射弁   | 23…圧力センサ      |
| 13…バイパス制御弁 |               |

[Drawing 2]

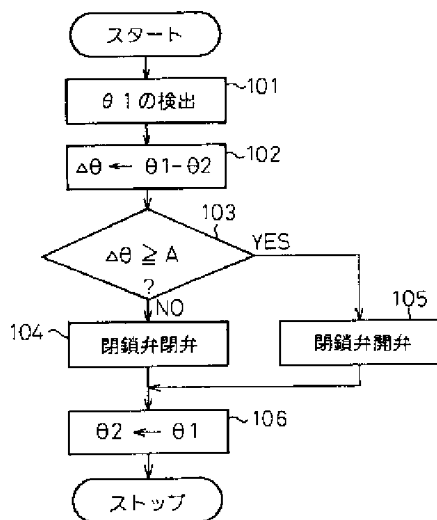


- |               |              |
|---------------|--------------|
| 11…燃料噴射弁      | 50c, 50d…連通路 |
| 50…アダプタ       | 51…エアアシスト通路  |
| 50a, 50b…燃料通路 |              |

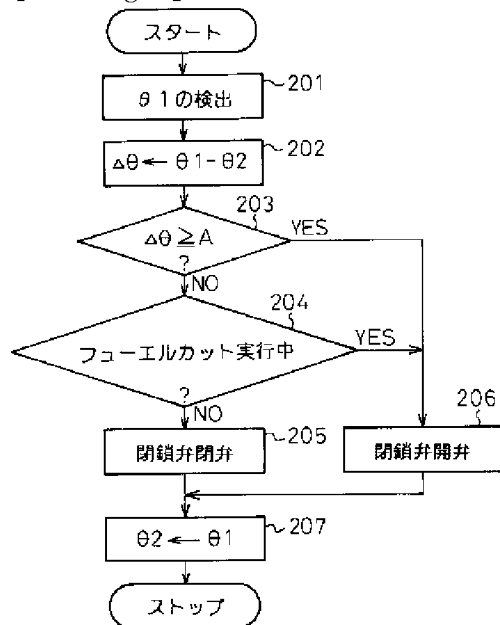
[Drawing 3]



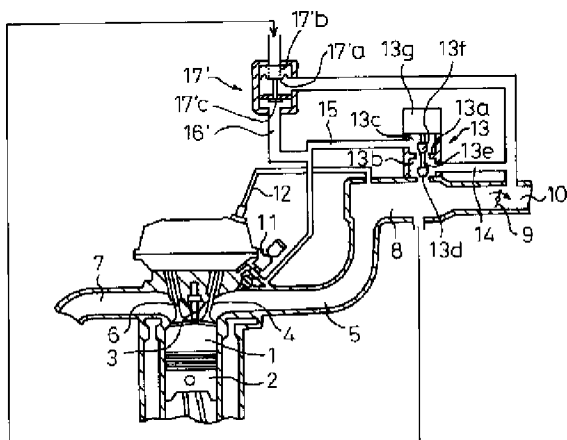
[Drawing 4]



[Drawing 5]



[Drawing 6]



- |            |            |
|------------|------------|
| 1…燃焼室      | 13…バイパス制御弁 |
| 4…吸気弁      | 14…第1接続管   |
| 5…吸気マニホールド | 15…第2接続管   |
| 8…サージタンク   | 16'…大気開放通路 |
| 9…スロットル弁   | 17'…閉鎖弁    |
| 10…燃料噴射弁   |            |

[Translation done.]

(11)特許出願公開番号

(43)公開日 平成7年(1995)9月26日

F 0 2 D 33/ 00 3 1 8 Z  
審査請求 未請求 請求項の数 3 O L (全 7 頁)

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## 【特許請求の範囲】

【請求項1】 吸気通路のスロットル弁上流側と前記吸気通路のスロットル弁下流に配置された燃料噴射弁の噴口近傍とを連通するエアアシスト通路と、前記エアアシスト通路に配置され、アシストエア量を制御するための制御弁と、前記エアアシスト通路の前記制御弁下流側を大気へ開放する大気開放通路と、前記大気開放通路に配置された閉鎖弁と、前記閉鎖弁を前記吸気通路のスロットル弁下流側の圧力上昇が所定値以上となる時に開放させる第一制御手段、とを具備することを特徴とする内燃機関の燃料噴射装置。

【請求項2】 さらに、前記閉鎖弁をフューエルカット時に開放させる第二制御手段を具備することを特徴とする請求項1に記載の内燃機関の燃料噴射装置。

【請求項3】 吸気通路のスロットル弁上流側と前記吸気通路のスロットル弁下流に配置された燃料噴射弁の噴口近傍とを連通するエアアシスト通路と、前記エアアシスト通路に配置され、アシストエア量を制御するための制御弁と、前記エアアシスト通路の前記制御弁下流側を大気へ開放する大気開放通路と、前記大気開放通路に配置された閉鎖弁と、前記閉鎖弁を前記吸気通路のスロットル弁下流側の圧力が所定圧力以上となる時に開放させる第三制御手段、とを具備することを特徴とする内燃機関の燃料噴射装置。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】本発明は、特に、噴射された燃料の微粒化を良好にするために燃料噴射弁の噴口近傍にアシストエアを供給するためのエアアシスト通路が接続される内燃機関の燃料噴射装置に関する。

## 【0002】

【従来の技術】このような内燃機関の燃料噴射装置は既に公知となっており、例えば、特開平4-295178号公報には、エアアシスト通路の上流側を制御弁を介して吸気通路のスロットル弁上流に接続し、スロットル弁の上流と下流との間に発生する差圧を利用して、燃料噴射弁の噴口近傍にアシストエアを供給する差圧式エアアシスト装置を有する燃料噴射装置が開示されている。この差圧式エアアシスト装置において、アシストエア量は前述の制御弁により調整され、スロットル弁を介して供給される吸気と合わせて、各機関運転状態において必要とされる吸気量が気筒内へ供給されるようになっている。

## 【0003】

【発明が解決しようとする課題】吸気通路は、機関高負荷時などの多量の吸気を通過させるために、その断面積が比較的大きくされる一方で、このようなエアアシスト通路の特に制御弁下流側は、アシストエアの流速を高めるために、その断面積は比較的小さなものである。それにより、機関急加速時のようにスロットル弁開度が急増

すると、吸気通路のスロットル弁下流側の圧力は素早く上昇して大気圧に近づくが、それに伴い制御弁の開度が急増されても、エアアシスト通路の制御弁下流側は、しばらく負圧のまま維持されるために、その間でスロットル弁下流側の吸気通路からエアアシスト通路へ吸気が逆流し、噴射された燃料の一部は、この逆流する吸気と共にエアアシスト通路へ流入し、この時の空燃比が所望値よりリーンとなって出力が低下すると共に三元触媒コンバータでの排気ガス浄化性能が悪化する。

【0004】従って、本発明の目的は、差圧式のエアアシスト装置を具備し、吸気通路のスロットル弁下流側の圧力の急上昇時に発生するエアアシスト通路への吸気の逆流及びそれに伴う燃料の流入を低減することができる内燃機関の燃料噴射装置を提供することである。

## 【0005】

【課題を解決するための手段】本発明による第一の内燃機関の燃料噴射装置は、吸気通路のスロットル弁上流側と前記吸気通路のスロットル弁下流に配置された燃料噴射弁の噴口近傍とを連通するエアアシスト通路と、前記エアアシスト通路に配置され、アシストエア量を制御するための制御弁と、前記エアアシスト通路の前記制御弁下流側を大気へ開放する大気開放通路と、前記大気開放通路に配置された閉鎖弁と、前記閉鎖弁を前記吸気通路のスロットル弁下流側の圧力上昇が所定値以上となる時に開放させる第一制御手段、とを具備することを特徴とする。

【0006】本発明による第二の内燃機関の燃料噴射装置は、前述の第一の内燃機関の燃料噴射装置において、さらに、前記閉鎖弁をフューエルカット時に開放させる第二制御手段を具備することを特徴とする。

【0007】本発明による第三の内燃機関の燃料噴射装置は、吸気通路のスロットル弁上流側と前記吸気通路のスロットル弁下流に配置された燃料噴射弁の噴口近傍とを連通するエアアシスト通路と、前記エアアシスト通路に配置され、アシストエア量を制御するための制御弁と、前記エアアシスト通路の前記制御弁下流側を大気へ開放する大気開放通路と、前記大気開放通路に配置された閉鎖弁と、前記閉鎖弁を前記吸気通路のスロットル弁下流側の圧力が所定圧力以上となる時に開放させる第三制御手段、とを具備することを特徴とする。

## 【0008】

【作用】前述の第一の内燃機関の燃料噴射装置は、吸気通路のスロットル弁上流側と吸気通路のスロットル弁下流に配置された燃料噴射弁の噴口近傍とを連通するエアアシスト通路と、エアアシスト通路に配置され、アシストエア量を制御するための制御弁と、エアアシスト通路の制御弁下流側を大気へ開放する大気開放通路と、大気開放通路に配置された閉鎖弁とを有し、第一制御手段が、閉鎖弁を吸気通路のスロットル弁下流側の圧力上昇が所定値以上となる時に開放するために、この時にエア

アシスト通路の制御弁下流側の圧力が素早く大気圧に上昇する。

【0009】また、前述の第二の内燃機関の燃料噴射装置は、前述の第一の内燃機関の燃料噴射装置において、第二制御手段が、閉鎖弁をフューエルカット時に開放させるために、この時にエアアシスト通路の制御弁下流側の圧力が素早く大気圧に上昇する。

【0010】また、前述の第三の内燃機関の燃料噴射装置は、吸気通路のスロットル弁上流側と吸気通路のスロットル弁下流に配置された燃料噴射弁の噴口近傍とを連通するエアアシスト通路と、エアアシスト通路に配置され、アシストエア量を制御するための制御弁と、エアアシスト通路の制御弁下流側を大気へ開放する大気開放通路と、大気開放通路に配置された閉鎖弁とを有し、第三制御手段が、閉鎖弁を吸気通路のスロットル弁下流側の圧力が所定圧力以上となる時に開放するために、この時にエアアシスト通路の制御弁下流側の圧力が素早く大気圧に上昇する。

【0011】

【実施例】図1は、本発明による第一実施例の燃料噴射装置が取り付けられた内燃機関の概略断面図である。同図において、1は燃焼室、2はピストン、3は点火プラグである。燃焼室1には、吸気弁4を介して吸気マニホルド5が、また排気弁6を介して排気マニホルド7が通じている。各気筒毎の吸気マニホルド5は、機関高負荷時の多量の吸気を通過させるために比較的大きな断面積を有しており、サージタンク8において合流し、その上流にはスロットル弁9が配置された各気筒共通の吸気通路10が接続されている。各吸気マニホルド5には燃料噴射弁11が配置されている。図中12は、クランクケースからカムカバー内へ導かれるブローパイガスをサージタンクに還元するためのブローパイガス還元装置である。

【0012】図2は燃料噴射弁11の断面図である。同図に示すように、その先端部にはアダプタ50が取り付けられている。このアダプタ50には、燃料噴射弁11の二つの噴口からその燃料噴射方向にアダプタ前端面まで延在する二つの燃料通路50a、50bと、アダプタ側面から各燃料通路50a、50bの燃料噴射弁噴口近傍に連通する少なくとも二つの連通路50c、50dとが形成されている。燃料噴射弁11の取り付け部には、アダプタ側面回りにエアアシスト室51が設けられ、そこに提供されるアシストエアが、連通路50c、50dを介して各燃料通路50a、50bに供給され、燃料噴射弁11により噴射される燃料を良好に微粒化してアダプタ前端面より放出するようになっている。

【0013】図1に戻り、サージタンク8の外側には、バイパス制御弁13が配置されている。このバイパス制御弁13内は、隔壁に13aによって上流側の高圧室13bと下流側の低圧室13cとに分割され、第1弁体1

3dを介して高圧室13bとサージタンク8とが連通され、第1弁体13dと同一弁軸13e上に配置された第2弁体13fを介して高圧室13bと低圧室13cとが連通されている。13gは、弁軸13eを介して第1弁体13d及び第2弁体13fを作動するためのアクチュエータである。高圧室13bは第1接続管14によって吸気通路10のスロットル弁9上流側に接続され、低圧室13cは第2接続管15によってエアアシスト室51に接続されている。

【0014】また、第2接続管15には、それを吸気通路10のスロットル弁9上流側、すなわち大気へ開放するための大気開放通路16が接続され、この大気開放通路16には閉鎖弁17が配置されている。

【0015】前述のバイパス制御弁13における第1弁体13d及び第2弁体13fの開度は、それらの形状によって弁軸13eの変位量に応じて図3に示すごとく変化している。図3において、実線は第2弁体13fの開度であり、この開度は、弁軸13eが所定変位量Aに達する時に全開となり、その間で全開から直線的に増加するようになっている。また点線は第1弁体13dの開度であり、この開度は、弁軸13eが所定変位量Aに達するまで全開のままであり、その後全開から全開まで直線的に増加するようになっている。

【0016】このように構成されたバイパス制御弁13は、通常運転時において、第2弁体13fが部分的に開弁され、従って第1弁体13dは全開とされ、スロットル弁9の上流と下流との間の差圧によって第2接続管15を介して燃料噴射弁11の噴口近傍にアシストエアを供給し、噴射された燃料の微粒化を促進するようになっている。この第2接続管15は、それを通るアシストエアの流速を早めるために、比較的小さな断面積を有している。また、冷間アイドル運転時において、燃焼を安定化させ早期暖機を実現するために回転数を高める際には、燃料と共に吸気量を温間アイドル運転時に比較して、ある程度増量しなければならず、この時には第2弁体13fが全開されてアシストエアを増加すると共に、さらに第1弁体13dも開弁されてスロットル弁9を迂回する吸気をサージタンク8へ供給するようになっている。

【0017】20は、このような一般的なバイパス制御弁13の制御を担当すると共に、前述の大気開放通路16に配置された閉鎖弁17の開閉制御を担当する制御装置であり、機関運転状態を検出するために、吸入空気量を検出するためのエアフローメータ（図示せず）、機関回転数を検出するための回転センサ（図示せず）、機関温度として冷却水温を検出するための冷却水温センサ21、スロットル弁9の開度を検出するためのスロットル弁開度センサ22、吸気マニホルド5内の圧力を検出するための圧力センサ23等が接続されている。図4は、この閉鎖弁17の開閉制御のための第1フローチャート

である。本フローチャートは、例えば、所定クランク角度毎に実行されるようになってい

【0018】まずステップ101において、スロットル弁開度センサ24によって現在のスロットル弁開度 $\theta_1$ を検出する。次にステップ102において、この値 $\theta_1$ から前回のスロットル弁開度 $\theta_2$ が減算されてスロットル弁開度増加量 $\Delta\theta$ が算出され、ステップ103において、この $\Delta\theta$ が所定量A以上であるかどうか判断される。

【0019】本フローチャートの開始直後は機関アイドル時であるために、当初、この判断は否定されてステップ104に進み、閉鎖弁17は閉弁され、ステップ106において今回のスロットル弁開度 $\theta_1$ が次の処理のために $\theta_2$ として記憶され終了する。一方機関運転中において、急加速のためのスロットル弁開度が急増すると、ステップ103における判断が肯定されてステップ105に進み、閉鎖弁17は開弁される。

【0020】一般的な差圧式エアアシスト装置を具備する燃料噴射装置は、このような大気開放通路16を有さないために、機関急加速時にスロットル弁開度が急増すると、比較的大きな断面積を有する吸気マニホルド5内の圧力は素早く上昇して大気圧に近づく一方で、比較的小さい断面積を有する第2接続管15内の圧力は、スロットル弁開度急増以前の負圧にしばらく維持される。従って、この時には、吸気マニホルド5から第2接続管15内へ吸気が逆流し、それに伴い噴射された燃料の一部が第2接続管15内へ流入して必要燃料量が燃焼室1へ供給されないために、この時の空燃比は所望値よりリーンとなり、出力が低下すると共に排気マニホルド7下流側の三元触媒コンバータ(図示せず)での排気ガス浄化性能が悪化する。

【0021】しかし、本実施例の燃料噴射装置は、このようにスロットル弁開度が急増する時、閉鎖弁17が開弁されて第2接続管15が大気開放通路16によって大気圧に開放されるために、この第2接続管15内の圧力も吸気マニホルド5と同様に素早く上昇して大気圧に近づき、これらの圧力差により発生する第2接続管15内への前述の吸気逆流及びそれに伴う燃料の流入は防止され、出力低下及び排気エミッションの悪化の問題を解決することができる。

【0022】従来の構成において、スロットル弁開度が急増する時、バイパス制御弁13の特に第2弁体13fを急激に全開とすることも考えられるが、前述のような微調節を可能とするバイパス制御弁13の駆動装置13gは、一般的に、弁体の開度を大幅に増減するのに比較的時間を必要とするために、それだけでは依然として前述の問題が発生する。

【0023】本実施例において、このようなバイパス制御弁13の開度制御を追加することで、さらに良好に第2接続管15内の圧力を上昇させることができる。さら

に、大気開放通路16は、第2接続管15のなるべく下流側に接続され、比較的大きな断面積を有する方が好ましく、大気開放通路16の閉鎖弁17は、少なくとも全閉から全開への優れた応答性を有するものが好ましい。また、第1フローチャートにおいて、閉鎖弁17の開閉制御に、スロットル弁開度増加量を使用したが、もちろん、圧力センサ23によって直接吸気マニホルド5内の圧力を検出し、その上昇量 $\Delta p$ が所定値B以上となる時にだけ閉鎖弁17を開弁するようにしても同様な効果を得ることができる。

【0024】図5は、前述の閉鎖弁17のもう一つの開閉制御のための第2フローチャートである。第1フローチャートとの違いは、フューエルカットの実行を判断するステップ204が追加され、フューエルカットが実行されている時にも閉鎖弁17が開弁されることである。フューエルカットは、一般的に知られているように、機関急減速時に燃料節約を目的として燃料噴射を停止するものである。

【0025】機関急減速時を含めスロットル弁開度が小さい時には、吸気マニホルド5内の圧力はかなり低下して大きな負圧が発生する。このような場合には、吸気弁4の潤滑油がバルブガイドを介して吸気マニホルド5内に漏れ、燃焼室1内で燃焼して消費されるオイル下がりが増加する。第2フローチャートによれば、吸気量を増加させても特に問題を生じないフューエルカット中において、第2接続管15内が大気開放通路16によって大気圧に開放されるために、この時に第2接続管15を介して多量のアシストエアが吸気マニホルド5内に供給されて、それ内の圧力を上昇させ、この時のオイル下がりを抑制することができる。

【0026】また、この多量のアシストエアは、この急減速以前の急加速時に第2接続管15内へ仮に燃料が流入しても、この燃料を吸気マニホルド5内へ確実に排出し、燃料による第2接続管15の腐食を防止することができ、さらに、燃料噴射弁11を十分に冷却して燃料噴射弁11内での燃料の気化を防止することができる。

【0027】図6は、本発明による第二実施例の燃料噴射装置が取り付けられた内燃機関の概略断面図である。第一実施例との違いについてのみ以下に説明する。本実施例において、大気開放通路16'には、差圧式の閉鎖弁17'が配置されている。この閉鎖弁17'は、そのダイヤフラム17'aの一方に吸気通路10のスロットル弁9上流側の圧力が作用し、他方にサージタンク8内の圧力が作用し、両者の差圧がバネ部材17'bの押圧力より小さくなると、ダイヤフラム17'aはバネ部材17'bによって変形されて、それに取り付けられた弁体17'cが開弁され、大気開放通路16'が開放されるようになってい

【0028】従って、吸気通路10のスロットル弁9上流側の圧力は大気圧であり、ほぼ一定であると考え

ば、サージタンク8内の圧力、すなわち吸気マニホルド5内の圧力が所定値以上となる時に閉鎖弁17'が開弁されることになり、この所定値を適用に選択することで、機関急加速中において第2接続管15は大気へ開放され、第一実施例と同様に前述の問題を解決することができる。

【0029】本実施例は、閉鎖弁17'が制御装置を必要としないで自動的に開閉されるために、第一実施例と比較して構造を単純化することができると共に、機関急加速時でなくてもスロットル弁9開度が増加して吸気マニホルド5内の圧力が所定値を越えると、第2接続管15は大気へ開放されることになり、この時、多量のアシストエアが燃料噴射弁11の噴口近傍に供給され、燃料の微粒化を向上させることができる。

【0030】二つの実施例において、大気開放通路16、16'の上流側は吸気通路10のスロットル弁9上流に接続されているが、独自にエアクリーナを設ければ、直接大気へ開放することも可能である。

【0031】

【発明の効果】このように、本発明による第一の内燃機関の燃料噴射装置によれば、吸気通路のスロットル弁上流側と吸気通路のスロットル弁下流に配置された燃料噴射弁の噴口近傍とを連通するエアアシスト通路と、エアアシスト通路に配置され、アシストエア量を制御するための制御弁と、エアアシスト通路の制御弁下流側を大気へ開放する大気開放通路と、大気開放通路に配置された閉鎖弁とを有し、第一制御手段が、閉鎖弁を吸気通路のスロットル弁下流側の圧力上昇が所定値以上となる時に開放するために、この時にエアアシスト通路の制御弁下流側の圧力が素早く大気圧に上昇して、吸気通路のスロットル弁下流側との間の圧力差が小さくなり、エアアシスト通路への吸気の逆流及び燃料の流入は抑制され、所望の空燃比を実現することができる。

【0032】また、本発明による第二の内燃機関の燃料噴射装置によれば、前述の第一の内燃機関の燃料噴射装置において、第二制御手段が、閉鎖弁をフューエルカット時に開放させるために、第一の内燃機関の燃料噴射装置の効果に加えて、スロットル弁が全閉に近いフューエルカット中にエアアシスト通路の制御弁下流側の圧力が素早く大気圧に上昇し、多量のアシストエアが吸気通路

のスロットル弁下流側に供給されてその圧力を上昇させ、この時のオイル下がり抑制することができる。

【0033】また、本発明による第三の内燃機関の燃料噴射装置によれば、吸気通路のスロットル弁上流側と吸気通路のスロットル弁下流に配置された燃料噴射弁の噴口近傍とを連通するエアアシスト通路と、エアアシスト通路に配置され、アシストエア量を制御するための制御弁と、エアアシスト通路の制御弁下流側を大気へ開放する大気開放通路と、大気開放通路に配置された閉鎖弁とを有し、第三制御手段が、閉鎖弁を吸気通路のスロットル弁下流側の圧力が所定圧力以上となる時に開放するために、機関急加速時等にエアアシスト通路の制御弁下流側の圧力が素早く大気圧に上昇して、吸気通路のスロットル弁下流側との間の圧力差が小さくなり、エアアシスト通路への吸気の逆流及び燃料の流入は抑制され、所望の空燃比を実現することができる。

【図面の簡単な説明】

【図1】本発明による第一実施例の燃料噴射装置が取り付けられた内燃機関の概略断面図である。

【図2】燃料噴射弁の拡大断面図である。

【図3】バイパス制御弁の二つの弁体の開度を説明する図である。

【図4】閉鎖弁の開閉制御のための第1フローチャートである。

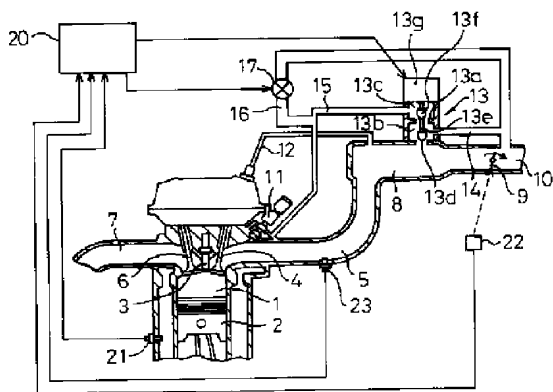
【図5】閉鎖弁の開度制御のための第2フローチャートである。

【図6】本発明による第二実施例の燃料噴射装置が取り付けられた内燃機関の概略断面図である。

【符号の説明】

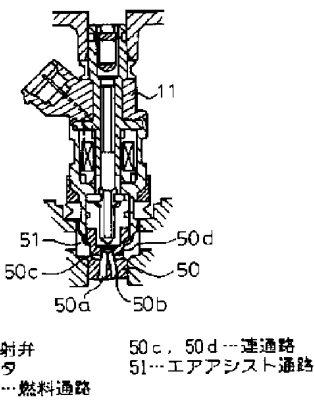
- 1…燃焼室
- 4…吸気弁
- 5…吸気マニホルド
- 8…サージタンク
- 9…スロットル弁
- 11…燃料噴射弁
- 13…バイパス制御弁
- 14…第1接続管
- 15…第2接続管
- 16, 16'…大気開放通路
- 17, 17'…閉鎖弁

【図1】



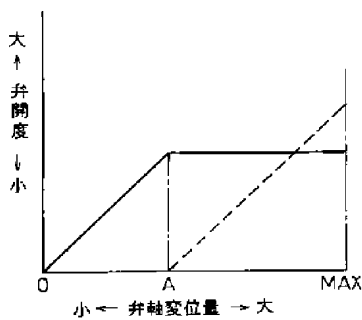
- 1…燃焼室  
 4…吸気弁  
 5…吸気マニホルド  
 8…サージタンク  
 9…スロットル弁  
 10…燃料噴射弁  
 13…バイパス制御弁  
 14…第1接続管  
 15…第2接続管  
 16…大気開放通路  
 20…制御装置  
 22…スロットル開度センサ  
 23…圧力センサ

【図2】

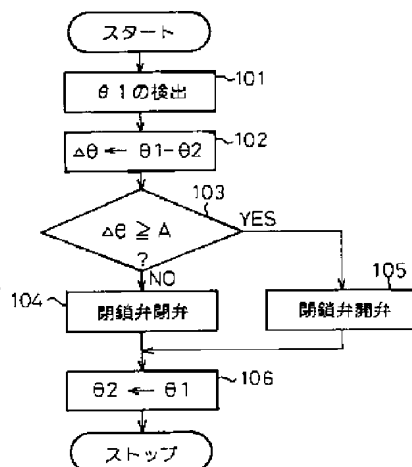


- 11…燃料噴射弁  
 50…アダプタ  
 50a, 50b…燃料通路  
 50c, 50d…連通路  
 51…エアアシスト通路

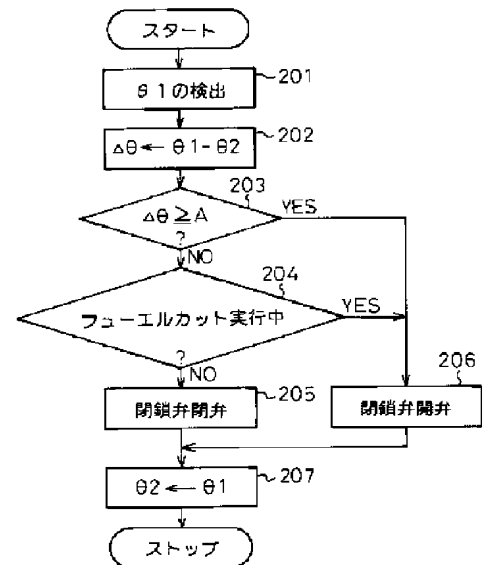
【図3】



【図4】



【図5】



This diagram shows a cross-section of the upper part of the device. It features a main housing (1) with various internal channels and components. Key parts labeled include: 17' (top left), 17'a (top center), 17'b (top right), 17'c (middle left), 16' (bottom left), 15 (central vertical component), 13g (top right), 13f (middle right), 13a (lower right), 13c (middle right), 13b (lower middle), 13e (lower right), 10 (far right), 9 (bottom right), 14 (bottom right), 8 (bottom middle), 13d (bottom middle), 5 (main body), 4 (inner channel), 3 (bottom left), 6 (bottom left), 2 (bottom center), 1 (bottom center), and 7 (left side). The diagram illustrates the complex internal structure and how different parts are interconnected.

- |            |            |
|------------|------------|
| 1…燃焼室      | 13…パイパス制御弁 |
| 4…吸気弁      | 14…第1接続管   |
| 5…吸気マニホールド | 15…第2接続管   |
| 8…サージタンク   | 16…大気開放通路  |
| 9…スロットル弁   | 17…閉鎖弁     |
| 10…燃料噴射弁   |            |